Exploring the Impact of Artificial Intelligence on Knowledge Management in Automotive Manufacturing within Different Cultures: China and Germany as Examples

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Abstract: This study explores the impact of artificial intelligence (AI) on knowledge management (KM) in the automotive manufacturing industry with a focus on different cultural contexts in China and Germany. The role of cultural factors on the effectiveness of AI in KM practices is explored by comparing automobile manufacturers in China and Germany. This study uses case studies to compare, and contrast leading automotive manufacturers in both countries and combines industry reports, papers journals, and other digital resources on the Internet to explore how the manufacturing industry can use AI technology to improve efficiency in the KM process. In addition, the study explores the impact of culture on organizational structure, decision-making, and employee engagement with new technologies within a company. The preliminary findings suggest differences in the understanding and use of AI and KM between China and Germany due to their different history, culture, and level of economic development. In China, the integration of AI into KM is driven by rapid technological advances and strong government support, focusing on efficiency and scalability. In contrast, German companies show more caution, emphasizing accuracy, reliability, and augmentation of human expertise. These differences reflect broader cultural attitudes toward technology and innovation in both countries. The study contributes to the understanding of the interaction between AI and KM in the context of cultural differences. The findings will have important implications for subsequent AI research and policy development.

Keywords: Artificial Intelligence, Knowledge Management, Automotive Manufacturing Industry

1. Introduction

1.1 Importance of AI in the Automotive Manufacturing Industry

AI plays an increasingly important role in the automotive manufacturing industry, mainly in several key application areas to improve efficiency, increase safety, promote innovation, and enhance customer satisfaction. Different application scenarios and means reflect different importance.

For example, AI can improve automation in automotive production lines, reduce human error, and increase productivity. At the same time, AI can analyze production data, optimize workflow, reduce waste, and improve resource utilization efficiency (Kamran et al. 2022). By using AI vision systems for real-time inspection and quality control of automobiles in production, defects, and non-compliant products are identified and corrected. This ensures product quality and reduces the need for rework and after-sales service. It can also help automakers manage their supply chains more efficiently by optimizing inventory levels through predictive analytics, forecasting demand, reducing surpluses or shortages, lowering costs, and improving supply chain transparency and flexibility (Hofmann et al. 2023; Jarrahi et al. 2023).

In automotive design and engineering, AI can assist in design decisions through simulation and predictive analytics, optimize vehicle performance including fuel efficiency, safety, and durability, play a role in material selection and engineering testing, and increase the speed of innovation (Demlehner and Laumer, 2020). Help automakers offer more personalized vehicle configuration options that optimize vehicle performance based on customer preferences and driving habits. In after-sales service, predictive maintenance can be used to reduce vehicle breakdowns and improve customer satisfaction. Although not directly involved in the manufacturing process, AI plays a central role in the development of autonomous driving technology and has a significant impact on the development of the automotive manufacturing industry enabling vehicles to understand their surroundings and make safe and effective driving decisions (Uludağ et al. 2019).

1.2 The Critical Role of KM in the Automotive Manufacturing Industry

KM plays a critical role in the automotive manufacturing industry, which involves creating, sharing, using, and managing information and knowledge within an organization. In a highly complex and technology-driven industry such as automotive manufacturing, by effectively managing and sharing internal knowledge, automotive manufacturers can accelerate the process of new product development and enhance innovations

ranging from new technologies to new design concepts. This helps companies maintain a competitive edge and respond quickly to market changes and consumer demands. KM systems can help employees quickly access production processes, operating manuals, and best practice guidelines, which can reduce errors and improve efficiency and quality control on the production line (Hofmann et al. 2023; Jarrahi et al. 2023).

The automotive manufacturing industry has a complex supply chain involving numerous suppliers and partners. Effective KM helps to increase supply chain visibility, optimize inventory management, reduce delays, and ensure efficient coordination of all aspects of the supply chain.

KM can provide the necessary data and information to support fact-based decision-making. This includes market trend analysis, consumer behavior research, and evaluation of competitor strategies, thus helping management make more informed strategic decisions. KM systems enable new employees to assimilate more quickly into the company, and by accessing the company's knowledge base, they can learn the company's workflow, culture, and standard operating procedures more quickly (Demlehner et al. 2021). For existing employees, it's also a great resource for continuous learning and career development. Automotive manufacturing involves multiple departments such as design, engineering, production, and sales. KM helps break down barriers between departments and facilitates cross-departmental information sharing and collaboration, which improves the efficiency and effectiveness of the entire organization. KM can also support better customer service.

The relationship between intelligent vehicles and knowledge management can be effectively analyzed through the lens of the DIKW hierarchy theory, which stands for Data, Information, Knowledge, and Wisdom. This theory provides a framework for understanding how raw data is transformed into meaningful knowledge and ultimately wisdom. Data Collection and Management， Intelligent vehicles are equipped with a multitude of sensors that collect vast amounts of data. Effective knowledge management begins with the efficient collection, storage, and processing of this data. This involves Data Aggregation， Data Filtering， and Data Storage. Information Processing. Once data is collected, it needs to be processed to become useful information. For instance, image recognition algorithms can identify pedestrians, vehicles, and road signs from camera data. The next step is to transform information into knowledge. Identifying patterns in data that can inform decision-making. For example, recognizing that a certain intersection tends to have heavy traffic at specific times. Machine learning techniques allow intelligent vehicles to learn from past experiences and improve their decision-making over time. Finally, the application of knowledge to make wise decisions involves. Using knowledge to make real-time driving decisions. For instance, deciding when to change lanes or how to navigate around obstacles. This could involve updating algorithms and models to better handle new driving scenarios.

The integration of DIKW in intelligent vehicles has several practical implications. Improved data processing and knowledge management can lead to safer driving decisions, reducing the likelihood of accidents. Intelligent vehicles can optimize routes and driving behaviors to reduce fuel consumption and travel time. Providing drivers and passengers with relevant information, such as traffic updates and optimal routes, enhances the overall travel experience. The DIKW hierarchy theory provides a valuable framework for understanding the relationship between intelligent vehicles and knowledge management. By effectively managing data, transforming it into useful information, and applying knowledge wisely, intelligent vehicles can make better decisions, enhance safety, and improve efficiency. The ongoing advancement in AI and machine learning technologies will continue to enhance this relationship, leading to even smarter and more autonomous vehicles in the future.

1.3 Impact of Cultural Factors on KM

KM is not only about technology and processes, but is also closely related to people, organizational culture, and social interactions, so the influence of cultural factors in it should be explored in depth. Among them, organizational culture has a significant impact on the creation, sharing, and utilization of knowledge. Some key cultural factors have a critical impact on KM (Ammal et al. 2021).

An open culture encourages communication and collaboration among employees and facilitates the free flow of knowledge. Trust is the cornerstone of knowledge sharing; only when employees trust each other are they more willing to share their knowledge and experience. Fostering a culture of continuous learning and innovation is critical to KM. In such a culture, employees are encouraged to explore new ideas, learn new skills, and see mistakes as opportunities to learn and grow (Zhao et al. 2022; Yan et al. 2023; Kuang et al. 2018).

The culture should support knowledge sharing and creation through rewards and incentives. If the organization rewards employees who contribute knowledge and help others, then this will encourage more knowledge-sharing behaviors. In highly hierarchical organizational cultures, greater power distances may impede the flow

of knowledge. Lower-level employees may be reluctant to share knowledge with their superiors, fearing that their ideas and feedback will not be valued. Both direct and indirect communication styles can influence KM. In cultures that favor direct communication, knowledge sharing may be more direct and frequent. Whereas in cultures that favor indirect communication, people may be more cautious and need to build stronger trusting relationships to share knowledge (Manik et al. 2022).

A culture's tolerance for risk can influence an employee's willingness to try new approaches or come up with innovative ideas (Grum, 2020). In cultures that tolerate failure, employees may be more willing to share their knowledge and experiences, including those attempts that did not succeed. Organizations in collectivist cultures that place more emphasis on teamwork may be more likely to implement KM practices because knowledge is seen as a shared asset of the team. Whereas in an individualistic culture, knowledge may be viewed as an individual's property and employees may be more reluctant to share it (Tubaro and Casilli, 2019).

2. Theoretical Background and Research Methodologies

2.1 Overview of Automotive Manufacturing in China and Germany

Germany is one of the world's most famous automobile manufacturers, has a long history of automobile manufacturing, and is the founding place of many automobile brands, such as BMW, Mercedes-Benz, Audi and Volkswagen.

The German automotive manufacturing industry has long been a leader in automotive technology and innovation, especially in high-performance vehicles, luxury cars, and automotive engineering and design. In addition, influenced by Germany's Industry 4.0, German automotive companies have invested heavily in research and development (R&D), with the German automotive industry totaling €39 billion in R&D worldwide in 2017, twice as much as a decade ago, and averaging about 6 percent of overall sales (Uludağ et al. 2019; Manik et al. 2022).

The German automotive industry accounts for around 35% of the total R&D investment in the German economy. This puts it well ahead of other sectors. In 2018, the Volkswagen Group invested €13.9 billion in R&D for the year, ranking it number one in the global manufacturing industry. Through this fine and mature division of labor in R&D and its continuous optimization, the German automotive industry as a whole continues to show great potential for innovation and rapid efficiency improvements (Tubaro and Casilli, 2019).

China is the world's largest automotive market, ranking first in passenger car sales, and in recent years the demand in the field of electric and new energy vehicles has grown rapidly. It is worth noting that the government has played a driving role in the development of China's automotive industry.

As early as 2015, the Chinese government put forward the "Made in China 2025" strategy, the core of which is to realize the comprehensive intelligence of the manufacturing industry, more and more manufacturing industries have begun to transform in 2015, and started to integrate with AI in depth (Jarrahi et al. 2023).

Since 2015, more and more manufacturing industries have begun to transform and deeply integrate with AI. Especially in the new energy automobile industry, not only has it invested large capital, but the government has also played an active role in promoting the development and popularization of the new energy manufacturing industry through subsidies and special policies, which has led to the rapid modernization of China's automobile manufacturing industry, and the development of many Chinese automobile brands, such as BYD, Geely, the Great Wall, and Hongqi, in both domestic and international markets. Many Chinese car brands such as BYD, Geely, Great Wall, and Hongqi are becoming increasingly popular in both domestic and international markets (Teece, 2019). With increasing cooperation with international companies, including joint ventures and technology sharing, the competitiveness of Chinese automobiles in the global market is also gradually increasing (Zhao et al. 2022; Kuang et al. 2018).

As shown in Figure 1 below, in general, the German automotive industry is known for its innovation and high-quality products, while the Chinese automotive industry is known for its large market size and fast-growing new energy vehicle sector. The automotive industries of both countries are in a constant state of development and change, with far-reaching impacts on the global automotive market and technological development.

Figure 1: Timeline of the development of the automotive industry in China and Germany

2.2 Automotive Manufacturing and AI Applications Analytical Methods

This paper divides the degree of manufacturing AI into four aspects, as shown in Figure 2. That is intelligent manufacturing, automatic driving systems, AI virtual assistants, intelligent networks, and through these four aspects of Sino-German AI technology and automotive industry intelligence analysis. The parameter selection criteria are as follows:

1. Intelligent manufacturing: mainly refers to the automation, intelligence, and networking of the manufacturing process through the Internet of Things, cloud computing, big data, AI, and other intelligent technologies. Intelligent manufacturing indexing is quantitatively analyzed in terms of the amount of funds invested in the automotive manufacturing industry's preliminary R&D, the proportion occupied by the automation of the production process, and the utilization rate of production data (Taherdoost and Madanchian, 2023).
2. Autonomous driving: a rating of the level of automation of a vehicle, with specific classification criteria as shown in Figure 3 (Manik et al. 2022).
3. AI Assistant: It is a specific application of AI technology in the field of life assistance. It uses advanced technologies such as natural language processing, machine learning, and deep learning to provide users with personalized and intelligent services.

If we quantify the evaluation standard of AI, we can measure the professional degree and experience of AI assistants by the accuracy rate of navigation and road conditions, the accuracy rate of safety monitoring data, and the degree of entertainment information service.

4. intelligent network: also known as an Intelligent Transportation System (ITS), refers to the close integration of communication technology, information technology, and transportation technology, in the road traffic information system, life and social facilities system, and automobile system at three levels, to promote the transportation operation of the intelligent network application system. It aims to create an intelligent transportation network that can address social, economic, and environmental challenges, including construction, operation, and maintenance. The information interaction rate,

information transmission rate, and information carrying capacity per bit are analyzed as indicators for evaluating intelligent networking when measuring intelligent networking (Teece, 2019).

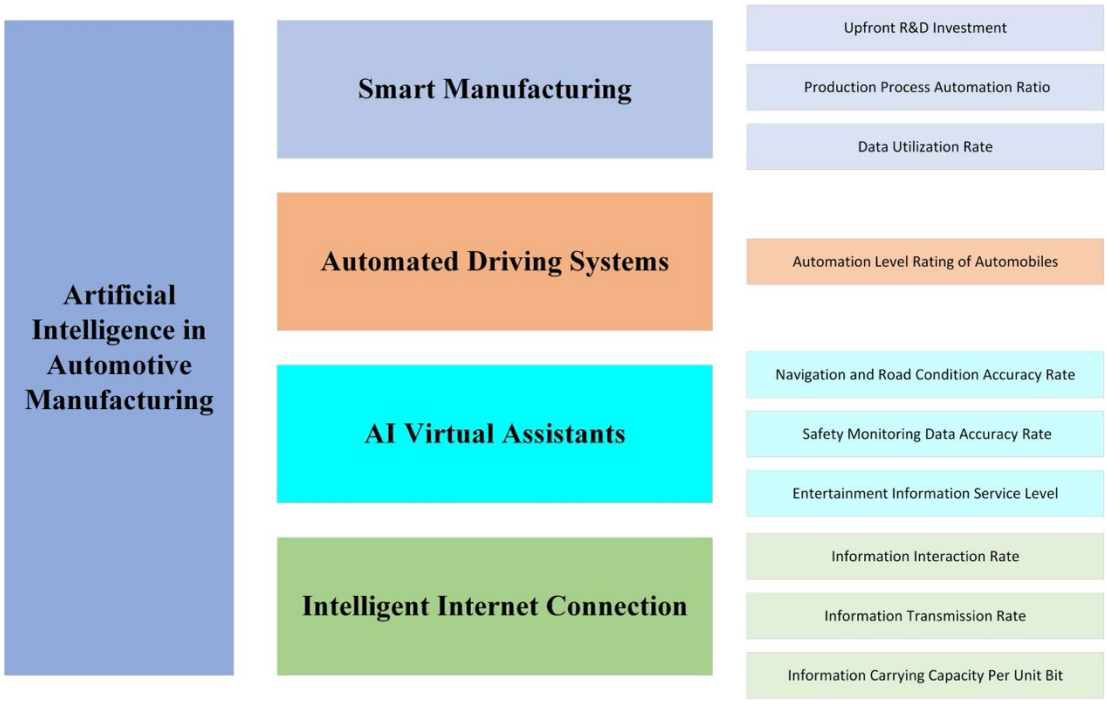

Figure 2: Quantitative criteria for the degree of intelligence in the automotive manufacturing industry

Figure 3: Rating criteria for automotive automation levels in this paper

2.3 Data Analysis

As seen in Figure 4 and Figure 5, the use of AI in China's automotive manufacturing industry is mainly focused on the pre-development of products, accounting for 51 percent of the total use of AI. The main use is reflected in the use of AI technology to automate the production process and improve production efficiency and quality control. By analyzing data from production equipment, AI can predict possible problems and maintenance needs of the equipment, reduce unplanned downtime, and improve productivity. This is the efficiency that China's manufacturing industry cares about the most. In addition to this, China's automotive manufacturing industry cares about user experience, such as the development and updating of AI virtual assistants, which account for 28% of China's manufacturing industry. Data from "China Intelligent Vehicle (Intelligent Connected Vehicle) and World Intelligent Vehicle Industry Speculation and Prospect Forecast Report, 2021-2024" published by China Automotive Industry Research Institute (CAIRI)

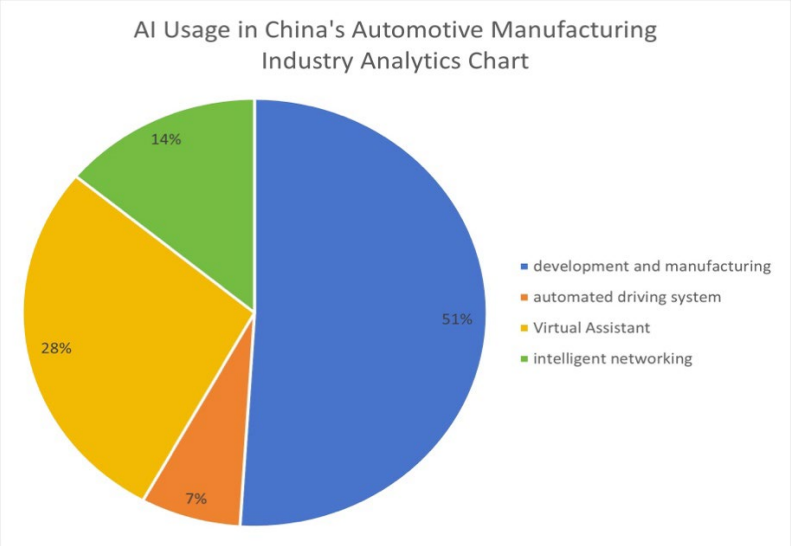

Figure 4: Percentage of intelligence degree of China's automobile manufacturing industry under this paper's standard

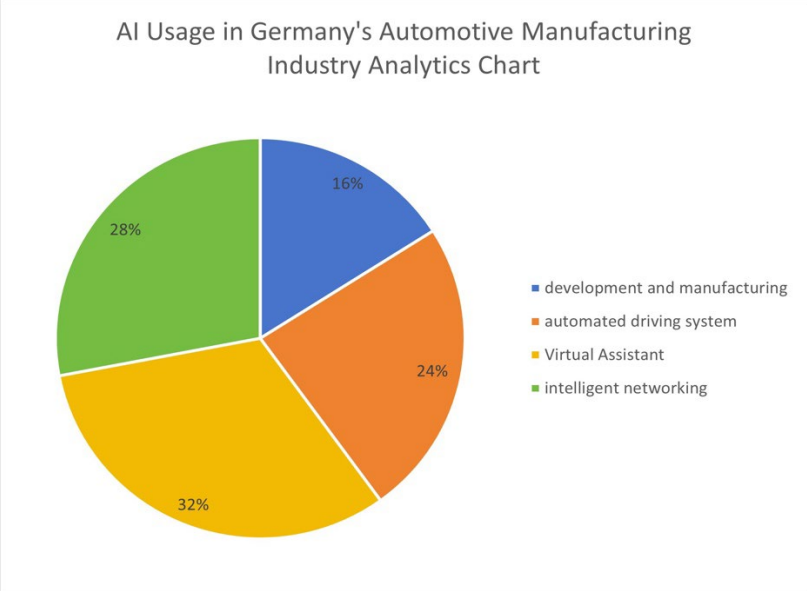

Figure 5: Percentage of intelligence degree of Germany's automobile manufacturing industry under this paper's standard

As seen in Table 1 below, the German automobile manufacturing industry in the use of AI, mainly concentrated on the late use of the product, and in the car's pre-development and design the use of AI accounted for only 16%, which has lot to do with Germany after the industrial revolution for the traditional fuel car obsession, from

the automation of the driving accounted for only 24% can be seen in Germany's new energy vehicle transition slower, in the international economic society Germany is lagging slightly behind in the international economic and social digitalization wave.

Table 1: AI in German Automotive Manufacturing

AI in German and China Automotive Manufacturing				
Areas of Application of AI	Development and manufacturing	Automated driving system	Virtual Assistant	Intelligent networking
AI in German Automotive Manufacturing Percentage	16%	24%	32%	28%
AI in China Automotive Manufacturing Percentage	51%	7%	28%	14%

The current background is that China is a global leader in key technologies and production levels such as batteries, motors, smart cockpits, etc., with an average range of over 460 kilometers for pure electric passenger vehicles, and many new technologies have emerged and taken hold in the country. China continues to make breakthroughs in the technological innovation of new energy vehicles. Battery technology is one of the keys to developing new energy vehicles. In recent years, Chinese enterprises have made remarkable progress in battery technology, such as China's latest generation of lithium iron phosphate batteries, which have an energy density of 180 watt-hours per kilogram and a range of more than 500 kilometers, which not only improves the energy density and range of batteries but also reduces the cost of batteries. AI is practically applied to the automobile manufacturing industry.

In recent years, Germany for using AI in the automotive industry, has also joined the R&D, Mercedes-Benz in the CES demonstrated the new MBUX virtual assistant. Based on large language modeling technology, its voice interaction is as natural as human communication; empowered by 3D graphic technology, its virtual image also has deep feelings and can express different emotions. It can integrate route guidance and driving assistance, presenting road environment information, navigation information, and dynamic information about the car in real-time and seamlessly on the screen. BMW Group also demonstrated a new voice assistant based on a large language model at CES 2024. The use of AI will be shown more fully. So what is the development of the German automotive industry for new energy vehicles? Official data shows that new car sales in Germany in February 2023 improved by 5.4% year-on-year to 217,388 units. However, Germany's progress on electric vehicles remains mixed, with sales of pure electric vehicles down 5% year-on-year, while plug-in hybrid electric vehicles (PHEVs) saw an increase in sales, with PHEV sales of 14,575 units, a 22% year-on-year boost (Uludağ et al. 2019).

With the use of AI, Germany as a result of the Industrial Revolution period ate the dividends of traditional fuel vehicles, coupled with the German automakers for traditional fuel vehicles manufacturing process has been skilled in the heart, want to break the routine there is a certain dilemma, which leads to Germany in the automobile manufacturing industry for the investment in new technology R&D, the transformation of the automated driving system there are ideological difficulties, and therefore companies want to develop new Energy is not enough power. In China, however, the government attaches great importance to environmental protection and has a strong interest in the development and use of new energy sources. In addition, China has maintained a high degree of enthusiasm for the digital economy in recent years. in 2023, China's new energy vehicle production and sales completed 9.587 million and 9.495 million units, respectively, an increase of 35.8% and 37.9% year-on-year, with a market share of 31.6%, and production and sales remained the world's first for nine consecutive years.

3. Comparative Analysis of KM in Chinese and German Automobile Manufacturing Industries

3.1 Differences and Similarities of KM in Chinese and German Automobile Manufacturing Industries

In recent years, Germany's federal education and research department set up a "future investment program" for the field of automotive machinery technology research and innovation to provide financial support. At the same time, Germany encourages German students to actively participate in automotive R&D and experiments for the internationalization of German brand vehicles and adopts various modes of KM to meet the needs and

challenges of the global market, such as centralized and unified intellectual property management, intellectual property management under the responsibility of R&D department, and joint management of intellectual property rights by the legal department and R&D department (Kamran et al. 2022).

China's automobile manufacturing industry has adopted various measures in KM, such as building a KM system, big data intelligence analysis, science and technology innovation knowledge service, and a new energy automobile national big data alliance to improve R&D efficiency, control costs and meet user needs.

Through the previous summary and analysis, we see that both Chinese and German automobile manufacturing industries attach importance to KM as a key factor to enhance competitiveness and innovation, but due to the differences in historical background, cultural characteristics, and market development stage, there are some significant similarities and differences between the two countries in the practice of KM. we will systematically compare and organize the two:

3.1.1 Similarities

Innovation emphasis: the automobile manufacturing industries of both countries attach great importance to innovation and regard KM as an important tool for promoting R&D and technological progress (Yan et al. 2023). This includes investment in new product development, and new technology applications (e.g. electric vehicles and autonomous driving technology).

Technology and digital applications: Both Chinese and German automakers are actively adopting advanced information technologies, such as AI, big data analytics, and cloud computing, to support KM and improve design, production, quality control, and customer service.

Global cooperation: Automakers in both countries recognize the importance of global knowledge sharing and international cooperation, and promote the exchange of knowledge and dissemination of best practices through cooperation with foreign partners, suppliers, and research institutions (Zhao et al. 2022).

3.1.2 Differences

Culture and organizational structure: German corporate culture is often more structured and hierarchical, emphasizing precision and quality control. KM systems tend to be more formal, emphasizing standardization and processes. In contrast, Chinese corporate cultures may be more flexible and dynamic, adaptable, and decision-making processes may rely more on relationships and networks. This may lead to KM practices that focus more on interpersonal communication and informal knowledge-sharing channels.

Knowledge sources and types: German KM tends to focus on internal R&D and the protection and utilization of long-term technology accumulation, valuing deep engineering knowledge and technological innovation.

China's automobile manufacturing industry, in its rapid development stage, is more likely to focus on integrating and absorbing international advanced technology and management knowledge, while at the same time rapidly enhancing its independent R&D capabilities (Demlehner et al. 2021).

Knowledge sharing and cooperation approach: German firms are likely to rely more on formal KM systems and procedures to facilitate knowledge sharing, such as through internal databases, standard operating procedures, and regular training. Chinese firms may rely more on informal networks and personal relationships for knowledge sharing, although formal KM practices are also being gradually established and improved.

Market orientation and customer needs: KM in German automobile manufacturing may focus more on product quality, innovation, and engineering excellence to meet the global market demand for high-end vehicles. China's automobile manufacturing industry may focus more on rapid market response and diversified needs in terms of KM, especially in the field of new energy vehicles and intelligent internet-connected vehicles, to adapt to the rapid changes in domestic and international markets. Based on these similarities and differences, the automotive manufacturing industries of the two countries show different effects on the application of AI.

3.2 Comparison of the Impact of Cultural Factors on KM in Chinese and German Automobile Manufacturing Industries

Through the above combined, it can be seen that the automobile manufacturing industries in China and Germany are affected by their unique cultural factors in KM, and these cultural differences have shaped the different practices of the two countries in knowledge creation, sharing, storage, and application, and we look at

the impacts of the different cultural factors on the automobile manufacturing industries in the two countries respectively:

3.2.1 Cultural Influences on China's Automobile Manufacturing Industry

Relationship orientation (relational): Chinese culture emphasizes interpersonal relationships and networks (i.e., "relationships"), which is reflected in KM by relying on strong personal relationships to facilitate knowledge sharing and transfer. Informal communication channels play an important role in knowledge flow (Demlehner et al. 2021).

Collectivism: Collectivist tendencies lead to a greater tendency for employees to work in teams and share knowledge, but at the same time may lead to individuals being less likely to initiate innovative ideas to avoid conflicting with the team's viewpoints.

Hierarchy: In a more hierarchical corporate culture, knowledge sharing may be hindered because subordinates may be reluctant to communicate information, especially critical or negative feedback, to their superiors.

Rapid Adaptation and Change: Flexibility and the ability to quickly adapt to changes in the market in Chinese corporate cultures help to quickly absorb and apply new knowledge, especially in areas of rapid technological advancement such as electric vehicles and smart internet vehicles (Taherdoost and Madanchian, 2023).

3.2.2 Cultural Influences in German Automotive Manufacturing

Structured and standardized: German corporate culture favors highly structured and standardized processes, which promotes the formalization and standardization of KM and helps to create, store, and share knowledge efficiently.

Quality and Precision: German engineering culture emphasizes quality, precision, and reliability, which is reflected in KM by high requirements for knowledge quality and strict control of knowledge creation and application processes (Ammal et al. 2021).

Risk aversion: The risk aversion tendency in the German culture may lead to more caution in knowledge innovation and trying out new methods, but it also implies more thorough evaluation before adopting and applying new knowledge.

Long-term planning and continuous improvement: The emphasis on long-term planning and continuous improvement in German corporate culture supports the emphasis on long-term knowledge accumulation and continuous learning in KM.

Based on this we integrate and compare the two and can find the different utility of cultural factors in the following three main aspects for KM in the automotive manufacturing industry in the two countries:

1. Knowledge sharing: In Germany, formal structures and processes promote systematic knowledge sharing, while in China, informal interpersonal relationships and networks play a more important role in knowledge sharing (Grum, 2020).
2. Knowledge innovation: The risk-averse tendency of German firms may lead to a cautious attitude towards knowledge innovation, whereas the rapid adaptability and ability to change of Chinese firms help to absorb and apply new knowledge quickly, especially in fast-changing markets and technologies (Uludağ et al. 2019).
3. Organizational structure: The hierarchical structure in the German automotive manufacturing industry may lead to vertical barriers in knowledge flow, while the hierarchical system in China may have an impact on knowledge flow both horizontally and vertically.

4. Conclusion

This study examines the impact of AI on KM in the automotive manufacturing industry in different cultural contexts in China and Germany. A comparative analysis of the Chinese and German automotive manufacturing industries provides new insights into understanding the impact of AI on KM in different cultural contexts and offers suggestions for KM practices in multinational enterprises in the context of globalization. The paper aims to emphasize the importance of adopting and promoting new technologies to understand and consider cultural factors. The study found that AI in both countries facilitated knowledge collection, analysis, and sharing, but the specific practices and ways of application differed. In China, automotive companies have shown a tendency to

adopt new technologies quickly and are very inclusive of new things, which is one of the reasons why Chinese-branded vehicles have gained international recognition in recent years. However, new technologies also bring new challenges, and the protection and management of digital knowledge is urgent. In Germany, automotive companies are adopting AI technologies with a greater focus on systematic and structured processes, reflecting their emphasis on quality and accuracy. This promotes the rigor and reliability of KM in Germany, in addition to the challenges it faces, such as increasingly stringent environmental regulations, the rise of electric vehicles, and global supply chain issues.

Based on the cultural specificities of China and Germany, then, we offer the following advice: For Chinese companies, it is important to focus on IP management and establish a sound legal and policy framework to support continuous innovation and technology development. German companies, on the other hand, can introduce more mechanisms to promote cross-functional cooperation and knowledge sharing to improve the organization's innovation capability and market responsiveness; on the other hand, they can encourage open innovation and external cooperation, pay attention to environmental regulations, and utilize external knowledge resources to strengthen the competitiveness of their enterprises. We believe that both Germany and China will have better development in the automotive industry. But while developing the automotive industry it is important to focus on understanding how different cultural backgrounds understand the use of AI.

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